

REPORT
OF THE
Agricultural Research Institute and
College, Pusa

(Including Report of the Imperial Cotton Specialist)

1907-'09



CALCUTTA
SUPERINTENDENT GOVERNMENT PRINTING, INDIA
1909

TABLE OF CONTENTS.

	PAGE.
I. Introductory	1
1. Agriculture	4
2. Botany	6
3. Agricultural Chemistry	7
4. Mycology	8
5. Entomology	10
6. Cotton	13
(a) Selection and Distribution of Seed	14
(b) Introduction of Superior Indigenous Varieties and Better Methods of Cultivation	15
(c) Hybridization	15
(d) Trials of Exotic Varieties	16
7. Tree Cottons	18
II.—Report of the Director, Agricultural Research Insti- tute, Pusa	19
1. Charge	19
2. Staff	19
3. Scientific Work	20
4. College, Grounds, Roads, etc.	20
5. Students	20
6. Publications	21
7. Library	21
8. General Health of the Station	21
III. Report of the Imperial Agriculturist	23
1. Charge and Establishment	23
2. Training	23
3. Cropping and Character of the Seasons	23
4. Special Crops under Experiment	25
(a) Sugarcane	25
(b) Jute	25
(c) Flax	26
(d) Tobacco	26
5. Manurial Experiments on Wheat	26
6. Green Manuring	27

	PAGE.
7. Permanent Manurial and Rotation Experiments	27
8. Permanent Pasture Experiments	27
9. Breeding	28
10. General Improvement of the Estate	29
11. Programme for 1909-10	29
IV. Report of the Imperial Economic Botanist	31
1. Charge of Office	31
2. Teaching and Training	31
3. Wheat Investigations	32
4. Fruit	35
5. Fibres	35
6. Oil Seeds	35
7. Minor Investigations	35
8. Tobacco	35
9. Programme for 1909-10	36
(1) Training	36
(2) Plant Breeding and Plant Improvement	36
(3) Fruit Experiments	37
(4) Minor Investigations	37
V. Report of the Imperial Agricultural Chemist	39
1. Charge	39
2. Introductory	39
3. Meteorology	39
4. Rainfall	39
5. Evaporation	39
6. Drainage	40
7. Loss of Water from Soil	41
8. Water required by Plants	42
9. Available Plant Food in Soils	42
10. Soil Gases	43
11. Black Cotton Soil	43
12. Other Investigations	43
13. General Analytical Work	43
14. Students	44
15. Establishment	44
16. Programme for 1909-10	44
VI. Report of the Imperial Entomologist	47
1. Training	47
2. Establishment	47
3. Buildings	48

	PAGE.
4. Provincial Work	48
5. Correspondence	49
6. Research	49
7. Sericulture	51
8. Lac	52
9. Insect Survey	52
10. Demonstration	53
11. Publications	54
12. Conclusion	55
13. Programme for 1909-10	55
VII. Report of the Second Imperial Entomologist	57
1. Charge and Establishment	57
2. Training	57
3. Work on Publications	58
4. Entomological Work	58
5. Correspondence	61
6. Conclusion	61
7. Programme for 1909-10	62
VIII. Report of the Imperial Mycologist	63
1. Charge and Establishment	63
2. Laboratory	63
3. Training	63
4. Organisation	64
5. Research Work	65
6. Sugarcane Disease	65
7. Palm Disease	65
8. Disease of Citrus Fruits	66
9. Wilt Disease	66
10. Mulberry Disease of Kashmir	67
11. Ginger Disease	67
12. Other Diseases of Plants	67
13. Silkworm Disease	67
14. Programme for 1909-10	67
IX. Report of the Imperial Cotton Specialist	69
1. Charge	69
2. Tours	69
3. Collection of Varieties	77
4. Distribution of Seed	77
5. Identification and Valuation	77
6. Programme for 1909-10	78

REPORT
OF THE
Agricultural Research Institute and
College, Pusa

(Including Report of the Imperial Cotton Specialist)

1907-09

INTRODUCTORY.

THE reports of the Director and heads of sections of the Agricultural Research Institute, Pusa, and of the Cotton Specialist for the years 1907-09, are herewith published. The period ends on the 30th June 1909.

The Institute was opened for advanced students only in July 1908. Before this 22 probationers came from various provinces for technical training in various sections, to adapt them for work of a very practical kind in the provinces concerned.

It has been definitely settled that Pusa shall chiefly be a higher teaching institution with post-graduate studies principally for selected graduates of provincial agricultural colleges and distinguished science graduates of Indian universities. Arrangements have, however, been made, for the time being, to give in agriculture, economic botany and entomology, short courses particularly in regard to the practical application of these sciences to every-day agriculture or horticulture in India. I attach great value

to these practical courses. A prospectus of the Pusa College has, for general information, been published.

Before I review in short detail the work done at Pusa, there are a few features of this Institute which I wish to clearly define. The first refers to the general suitability of Pusa for the central research and experimental station for the whole of India. Pusa is a magnificent estate of over 1,300 acres, bounded on three sides by a loop of the little Gundak river. The soil is deep alluvial and is capable of growing successfully nearly every rain crop which can be grown in the plains of India. With irrigation from wells or from the river, it can grow successfully the majority of the more important garden crops. We have arranged for all necessary means of irrigation from the river and from wells, also for dealing with many important crops. The rainfall of Pusa and of Behar is generally secure, otherwise the district could not maintain its population of 900 to 1,100 per square mile. Pusa is situated in the heart of intensive agriculture which is largely controlled by a community of indigo planters. Agricultural improvements through their influence, can be brought to the notice of ordinary cultivators in a manner which is unique for other parts of India. This was one reason why Pusa was selected as the central research station. Mr. Coventry, an experienced indigo planter and an extensive experimenter in agricultural problems, was selected as the Director. He has very particular opportunities of spreading very far afield the results of the research work and of the practical field enquiries which are undertaken at Pusa.

We have at Pusa the Phipps' laboratory, a two-storied building, well-equipped with a laboratory for each branch of agricultural science and a physical laboratory. The main building also includes a library, museums for the various sections and the necessary lecture rooms. Quarters have been provided for the European and Indian staffs. There are recreation grounds, and I am glad to

say that the European staff, assistants and students are keen on sports. A hostel with accommodation for 70 students is provided, also a well-equipped hospital and dispensary.

All sections were very badly housed at Pusa in temporary laboratories for some time. The head of each section now rejoices in having a well-equipped laboratory with all necessary fittings and apparatus. The Institute is served by water-power and electric installations.

The amenities of the estate have been much improved in many ways. A new approach avenue to the Institute has been constructed, and the lawns surrounding the college building have been laid out under irrigation and sparsely planted parklike with trees and ornamental shrubs. The scrub and jungle growth on the estate has been mostly cleared, thus making preparation for bringing waste land under cultivation. The unsightly brick-fields near the entrance to the estate, have been levelled and are now under cultivation with suitable ordinary crops. An area of some 150 acres has been reclaimed for arable cultivation. Practically the whole of the estate is now under grass or cultivation.

It has been proved in the past that the Pusa estate is capable of growing very fine timber trees in the avenues and elsewhere; consequently we are endeavouring to improve the attractiveness of the estate by planting and protecting young trees in the pasture areas, along the frontage of the river and in the avenues. The existing teak, shishum, bamboo, and mahogany avenues are an object lesson to many parts of India. We even expect to improve upon these. The fruit orchards and botanical area are now attractive features. A large vegetable garden is maintained. Many suitable trees on the riverside land have been inoculated with lac.

Nineteen students in all the various sections were admitted for training in 1908-09. In regard to the scientific and practical teaching in the lecture rooms, in the laboratories and in the fields at Pusa, my chief desire is that it

should be a means of helping, in a very practical way, the ordinary or improved agriculture of this country. I wish, therefore, to attract, from provincial agricultural colleges and from other colleges, students of high class ability who have been reared on the land.

Many of such students are usually poor and cannot afford the expense of an advanced course in research work. Government have spent of late years large sums on the development of agriculture, and I am confident that Indian gentlemen generally interested in the work will do their share. There is perhaps no direction in which there is more scope for liberality of the most useful kind than in the founding of scholarships for students at Pusa.

I refer below to some of the work done in each section at Pusa and by the Cotton Specialist. A full review of each report is not required here.

Agriculture.—Mr. E. Shearer, Imperial Agriculturist, has done much useful work for the Department. He was absent on privilege leave from 2nd July to 30th September 1908, when his duties were carried on by the Director.

Permanent manurial and rotation experiments were laid down last year on two blocks of 9 acres each. The land selected for these experiments has been tested and found sufficiently uniform for the purpose.

Permanent pasture experiments were laid down in the monsoon of 1907. It is very important to know the best conditions in various parts of India under which pastures can, on practical lines, be properly established and improved. This is the aim of the Pusa experiments, and it is believed that the results will be of very wide application, especially as similar grass experiments have been undertaken in some provinces. Already there is a decided change in the character of the herbage in some of the manured plots at Pusa.

Arable areas which are likely to be suitable for the extension of experimental work in the future, are being treated uniformly in regard to cultivation and cropping.

The more important crops under trial at Pusa include wheat, barley, oats, maize, rice, various pulses, oil-seeds, sugarcane, jute, flax, and tobacco. Efforts are being made to obtain and acclimatise the best indigenous and foreign varieties of these crops. Cotton varieties have been given up, as nearly all are unsuitable to Behar.

Perhaps the most important line of work in the Agricultural Section at Pusa, refers to the breeding and rearing of farm live stock. A very select herd of Montgomery cattle, the premier milk breed of India, is maintained. A record of the milk yield of each cow is kept. It is hoped to raise the milking standard (which is now very high) by selection on the basis of these records, and to breed these cattle of one colour and of one type. I draw attention to an interesting illustrated note which will appear in the October number of the *Agricultural Journal of India* for 1909. It refers to a large and remunerative export trade in Indian cattle which has recently arisen. Probably no Indian breed will meet the requirements of this foreign demand better than Montgomery cattle. They are useful for milk, for work and for beef, and in South Africa, in the Southern States of America and in the Straits Settlements they must prove useful, because pure and half-bred Indian cattle have been found to thrive well in these parts and are not affected by flies and ticks in the same disastrous way as local cattle.

Last cold weather 80 Bikanir ewes were purchased. These are a white-fleeced breed with a high reputation for yield and quality of wool. They are being crossed by *dumba* rams to give them hardiness and obtain improvement in the crosses as mutton and wool sheep.

Poultry breeding is now conducted on a fairly large scale. During the last year 19 breeding pens of fowls representing 10 pure breeds and 3 crosses, have been maintained including turkeys, geese and ducks. The experience so far gained indicates that the breed of fowl fully suited to India will have to be developed by crossing.

With this aim in view various experiments are being tried at Pusa. Many enquiries are received for pure bred birds and for eggs for hatching. The farms in several provinces have been supplied with birds, and large orders are being booked from private individuals, chiefly in Madras and Burma. Some of the pure and cross breeds reared at Pusa are being tried experimentally in the hills to determine how they stand the climate.

Botany.—Mr. Howard has done a great deal of useful work for the agriculture and horticulture of India.

He continued to be in charge of his section at Pusa except when he was on leave for six months from August 8th, 1907, to February 8th, 1908, when Mr. R. J. D. Graham, Supernumerary Economic Botanist, carried on the work of the section.

The most important work done by Mr. Howard during the period under report is in relation to wheat. He has nearly completed the botanical survey of the wheats of India. The results are given in the first section of his book, *Monograph on Indian Wheats*, now in the press. Samples of wheat were sent to Mr. Humphries in England for milling and baking tests, the results of which are published in a bulletin. At Pusa several promising wheats have been isolated by selection and are now being tested for yield, agricultural characters and grain qualities.

The plant-breeding work in wheat is now being conducted on a fairly large scale, and the separate cultures, many hundreds in number, extend over several acres. The main objects of this hybridization work are to improve the grain, straw and rust resistance of the Indian wheats. Considerable progress has been made in the investigation into the influence of soil, climate and moisture on the character of the grain in wheat.

Fruit cultivation on an extensive scale has been successfully established. Most of the fruit trees are coming into bearing. The fruit experiments at Pusa have already

yielded results of considerable practical importance. They have proved the suitability of the soil and climate in Behar for growing certain important varieties of fruit.

Preliminary experiments with high class fruit regarding sun-drying, evaporating and refrigerating, have been carried out. A method was devised and successfully tested for sending peaches long distances by rail in India.

During the past year a considerable amount of preliminary work was accomplished by Mr. Howard on oil seeds of the genus *Brassica*, and a general study of the oil seeds of India will be undertaken.

The races of both *Nicotiana rustica* and *Nicotiana tabacum* isolated at Pusa, have been studied. Arrangements have been made with the Peninsular Tobacco Company of Monghyr to conduct experiments at Pusa to ascertain the best varieties and the best means of growing tobacco suitable for the manufacture of cigarettes.

Selection experiments with flax, *Hibiscus cannabinus* and *Crotalaria juncea*, were continued, and some promising races isolated.

Three varieties of sisal hemp (*Agave rigida sisalana*) have been established on a small scale.

Progress has been made in the investigation work with barley, *ganja* and opium. The study of the varieties of cassava has been completed, and Mr. Hector is preparing a final report on this subject.

Agricultural Chemistry.—Dr. Leather held charge of this section till 14th April 1909, when he went on leave, and the Supernumerary Agricultural Chemist, Mr. Annett, was appointed to officiate for him. Very few samples of agricultural materials are now sent up by provincial departments for analyses, as these departments have now their own chemists. An appreciable reduction has also taken place in the number of samples received from Native States, the Forest and Irrigation Departments and private persons. Dr. Leather had, therefore, more time for

original research and for larger investigations of importance to Indian agriculture generally.

The work in the pot-culture house has led to important field experiments, the results of which are likely to benefit cultivators at least in Behar in a very substantial way. These field experiments are devised to show that phosphatic manure can with economy and great advantage, be used for certain soils and many crops, particularly in parts of the Gangetic alluvium and especially in Behar.

The Imperial Agricultural Chemist has a very important investigation in progress on the effect of soil or manure on the composition of certain seeds. The results already obtained are remarkable. In conjunction with the Imperial Entomologist, Dr. Leather is investigating the prevention of injury by weevils to wheat and other grains when stored in bulk. This enquiry is of great importance, particularly as it is probable that the American "elevator system" of storing grain may be introduced into India at least on an experimental scale. Mr. Annett has conducted an interesting enquiry into the cause of the dark colour of the black cotton soil. The results of this enquiry are about to be published.

Mycology.—Dr. Butler held charge of this section till 31st March 1909, when the Supernumerary Mycologist, Mr. W. McRae, M.A., B.Sc., was appointed to officiate for him. Mr. McRae arrived in India after deputation for six months to the laboratory of Professor von Tubeuf at Munich. The transfer of the laboratories to the Phipps' building has greatly facilitated the work of this section.

Dr. Butler should be congratulated in regard to the practical application of his work to the ordinary conditions of Indian agriculture.

The requirements of provincial departments still continue to make heavy calls upon the time of the Imperial Mycologist. Collections are being accumulated and worked out with such voluntary assistance as can be got outside

India. Duplicate collections will be as far as possible supplied to provincial departments which already have mycological assistants.

The fungi hitherto recorded from India have been in great part identified, and the information has been made readily accessible.

The research work includes the examination of the life-history and general biology of parasites and their effects on the attacked plants.

The wilt diseases of cotton, indigo, pigeon pea and gram were selected for special study, and the results already obtained will largely help Indian agriculture. A memoir on the work is now in the press. The experiments at the Poona farm to raise a strain of pigeon pea resistant to the wilt disease, have been in progress for four years and are promising well.

Renewed experiments were made to elucidate the methods of infection of the red-rot disease of sugarcane which in India has been for a considerable period a very disastrous disease to this important crop. It is hoped that the new results will be published during the year, and advice of importance given. The study of the life-history of other sugarcane parasites has not yet reached the publication stage.

Dr. Butler inspected the palm disease operations in the Godavari delta in September and December 1907 and in January 1909. Successful inoculations with the parasite were secured during 1908, and a further study of its life-history was made. The campaign against this disease has been particularly successful, and is still being prosecuted earnestly by means of the special staff sanctioned by the Madras Government. I must note the fact that the results of this enquiry by Dr. Butler are so valuable to India that they are equivalent to saving the cost of his section to India for many years to come.

The Imperial Mycologist visited Travancore in September and October 1907 to investigate the cocoanut palm

disease that had broken out in that State. A report on that disease has been published.

The Imperial Mycologist visited Kashmir in 1908 during the months of July, August and September, and enquired into diseases of mulberry and of imported fruit trees. The result of part of this work has been published, and recommendations made for dealing with mulberry diseases. The problem is very important, as many poor people in Kashmir derive much benefit from the silk operations and from the cultivation of good kinds of fruit.

Dr. Butler will complete in a short time the text of a book on Indian plant diseases. It will be of great value to students of agriculture in India.

Entomology.—Mr. Lefroy held charge of this section during the period under report. His indomitable energy appears throughout the work of his section. He continued to direct the work of entomological assistants in the provinces, but their number is still only 13, which is quite inadequate to make an appreciable impression upon the agriculture of India. A beginning only has been made.

The teaching of entomology at the provincial agricultural colleges and also at demonstrations and at shows has made fair progress.

Attention has been given in provinces to the study of the life-histories and habits of injurious insects.

In the Punjab the effects of cotton boll-worm and its parasites has been closely watched.

The work on the insects of the plains of India was continued.

Assistance was given to firms dealing with *mohwa*, with brush-making and with cheroots in regard to insects damaging these articles.

Valuable results have been obtained in the cultivation of *eri*-silk during the past year on a small scale at Pusa, and it is intended to continue this as the basis of a small cottage industry in several parts of India. This industry

is being taken up in Tirhoot and Gujarat. The purely experimental work on *eri*-silk is almost completed. The cultivation of mulberry silk has been taken up.

The question of *tussar* silk is also being investigated.

The cultivation of lac was continued at Pusa as a demonstration to students and for much wider practical application in villages. Some owners of indigo factories in Behar have taken up lac cultivation on a fairly large scale. These men were supplied with seed and information, and their assistants were trained in lac culture. Assistance was also given to the Bikanir State in regard to the possibilities of lac culture there.

Mr. Lefroy has started apiculture with a few stocks of European bees to determine how far they thrive in the plains of India.

The Supernumerary Entomologist, Mr. Mason, visited the various centres at which army stores are baled and stored, to investigate the occurrence in clothing, etc., of the destructive insect *Anthrenus vorax*. On the completion of this enquiry recommendations were made for better baling. Mr. Mason continued the enquiry into the value of insect eating birds.

The general collection of insects of India apart from the purely economic one, has been completely arranged.

Enquiry into the question of preventing the introduction of fungus and insect pests by importation of plants and seeds was made in order to devise remedial measures.

The text-book on *Indian Insect Pests* continues to increase in popularity. Its translation in Bengali has been prepared.

Mr. Lefroy's great work on *Indian Insect Life* has been issued.

A series of excellent coloured plates with short printed explanations illustrating injurious insects, have been issued for use in agricultural colleges, museums and farms and at

exhibitions and shows. This series will be continued and will cover silk, lac, bees and beneficial insects.

The best methods of preparing exhibits of injurious insects for shows are also being tested with a view to find out the class of exhibits that most appeal to the public. Further, a series of lantern slides in colour are being prepared in order that lantern lectures may be given at such shows.

Mr. Howlett, Second Imperial Entomologist, arrived at Pusa in December 1907. He has undertaken the investigation of those biting flies of whose habits little or nothing has been hitherto known in India. With a view to obtain materials for this enquiry, sets of apparatus and copies of the bulletin on biting flies, have been issued to persons and associations likely to render help. In this connection Mr. Howlett is in complete touch with special officers of the medical and veterinary departments. He arranged in February 1909 an exhibition of all kinds of blood-sucking and parasitic insects for the pathological section of the Bombay Medical Congress, and read a paper on the habits of sand flies. He has ascertained the life-histories of nearly all the mosquitos which occur in Pusa, and has found two species of fish which are capable of destroying large numbers of anopheles larvæ. A report on the natural enemies of mosquitos was furnished to the Director of Agriculture, Bengal.

A comprehensive investigation of the several species of fruit flies which attack mangoes, peaches, etc., is in progress. The life-histories of several of these have been worked out, and methods of destroying the mango fly have been tested with success. An attempt to check the annual attack of these pests on the peaches grown at Pusa, was so far successful this year that the period of severity was postponed; thus the Imperial Economic Botanist was able to complete certain experiments.

Mr. Froggatt, Entomologist to the Government of New South Wales, visited Pusa in June 1908, to obtain informa-

tion regarding the fruit flies in India, the Australian fruit flies being related to those found in India. Specimens have, therefore, been supplied to him.

Arrangements have also been made with Professor Silvestri to supply parasites of some of the South Indian species in the hope that they may be utilized against the olive fruit fly, a species which inflicts great damage in Italy.

Specimens have been lent to the Indian Museum, Calcutta, in connection with the revision of nomenclature of various groups of Indian diptera. A large representative collection of tabanidæ has also been lent to the British Museum to assist in like manner the revision of that family now in progress.

Mr. Howlett contributed to *Indian Insect Life* the portions relating to Diptera and the sections on Mallophaga, anoplura and cimicidæ.

A memoir on sand flies is under preparation in collaboration with Dr. Annandale of the Indian Museum.

Mr. Howlett controls the work of the artists at Pusa and is endeavouring to raise the standard of illustration work which is a most valuable part of the publications of the Imperial department.

Cotton.—Cotton continued to receive a great deal of attention from the agricultural departments. Mr. G. A. Gammie who has done much useful work in cotton, was appointed Imperial Cotton Specialist in December 1907. His report is separately published with those of the heads of sections at Pusa. It is unnecessary to minutely review it here. The co-ordination of the experiments that are being conducted on this crop, will now be possible, and Mr. Gammie's advice in the improvement of cotton ought to prove of great help to the department. The principal lines of improvement attempted have been (a) selection and distribution of cotton seed, (b) introduction of superior indigenous varieties and better methods of cultivation, (c) hybridization and (d) trial of exotic varieties.

(a) SELECTION AND DISTRIBUTION OF SEED.—The distribution of seed of selected pickings from cultivators' fields, has been in progress for more than four years in several provinces, but without any marked result. This is hardly surprising, for such selection, while no doubt supplying sound seed, is, properly speaking, no selection at all, since the fields ordinarily contain many varieties mixed together. It is by separating types and continued plant-to-plant selection that real improvement can be effected. This line of work is now being followed on Government experimental stations with very encouraging results. On the Surat farm, the different types found mixed in Khandesh cotton have been isolated and have been sown separately to determine the comparative value of each. Similar experiments are in progress in Madras. At Akola in the Central Provinces promising work is in progress in the separate cultivation of the four distinct varieties of cotton which are now grown mixed by the *ryots* under the names *jari* and *kati vilayati*. Of these the *malvensis* seems to be a distinctly superior variety, and special attention is being directed towards selection from it.

Eight cotton seed farms were worked by private agencies in the Central Provinces in 1908 under the guarantee of the provincial department against loss. Such farms have been in existence for the last four years. They grow the ordinary *jari* and *bani* varieties of cotton, but are situated in districts which have special reputation for the high quality of their cotton. The seed of first and second pickings is purchased by the provincial department at more than market rates for distribution. In course of time when the selection now going on at the experimental stations has borne fruit, these farms will become useful agencies for the distribution of improved strains of seed. The ultimate object is to establish a number of such farms independent of the department, but receiving, when required, assistance in the provision of seed, trained staff or advice. In the Punjab, Bengal and United Provinces, selection of cotton seed is in progress.

(b) INTRODUCTION OF SUPERIOR INDIGENOUS VARIETIES AND BETTER METHODS OF CULTIVATION.—There has been a marked extension of this line of work, especially in Bombay and Madras. The introduction of Broach cotton into the Dharwar district has been attended with considerable success. This cotton is superior to the locally grown *Kampta* variety not only in quality, but also apparently in average yield per acre and in lint percentage. In 1908 sixteen thousand pounds seed of Broach cotton from Navsari were sown in these parts in addition to some of the seed of this crop grown locally in 1907. Steps are being taken to get the people to cultivate it properly and to adopt a cleaner system of picking. Some efforts were made to introduce Broach cotton under irrigation in the Deccan, but owing to faulty cultivation and irrigation on the part of the cultivators, the experiments were not successful. Attempts have been made to improve the quality of Broach cotton in northern Gujarat by introducing seed of the superior Navsari variety from the south of the district. In the Tinnevely district of Madras the *karungani* variety has been found to be superior in quality and yield to the *uppani* variety. Arrangements were, therefore, made by the provincial department to sell pure *karungani* seed sufficient to sow about 8,000 acres in 1908. This work was partly helped by the grant from the British Cotton Growing Association. The Madras Agricultural Department has also made successful efforts to improve the *ryots'* methods of cotton cultivation. Expert cultivators are sent to teach the use of the country drill and bullock-hoe and to demonstrate the value of improved cultivation. Implements are supplied free of cost and expert labourers are sent to help the growers. The advantages of the drill are becoming widely appreciated, and in all 1,000 acres of private land were sown with the drill last year, and many *ryots* have learned to use the drill.

(c) HYBRIDIZATION.—Experiments in hybridization were continued at several centres. They have brought to light

some new ideas which, however, require confirmation. The crosses at the Surat farm have been found to be undergoing considerable variation. Although their lints have a relative advantage in quality over the ordinary Surat cotton, the ginning percentage is steadily falling. (The percentage has fallen from 36.9 to 30.3 during the last five years.) The crosses have not yet been grown on a sufficiently large scale to properly test the outturn per acre. The lints of 21 hybrids grown on the Surat station were valued from 5 to 10 per cent. above fine Broach. At Dharwar some encouraging results have been obtained by crossing *inter se* newly introduced varieties from America and Egypt. Work on similar lines is being done in the Central Provinces and Madras, but until the hybrids show greater stability it is impossible to estimate their value.

(d) TRIALS OF EXOTIC VARIETIES.—Trials of exotic varieties on Government farms and in cultivators' fields were continued. It is disappointing to have to record a set-back in the expectations previously formed regarding Egyptian cotton in Sind. Up to 1907 the area under this cotton was increasing, but last year, owing to the short supply of water till long after the proper sowing season, the area decreased, and the quantity and quality of the produce much deteriorated. Further, on account of faulty methods of cultivation, careless picking and admixture of leaves and dirt, the produce was so inferior that great difficulty was experienced in disposing of it. There were no bidders at the three auctions held in November, December and January last. The cotton was ultimately sold to a Bombay firm who wanted it for a particular trade purpose and paid only Rs. 9 per maund for *abassi* and Rs. 8-6-0 for *metafi* as against a minimum of Rs. 11 per maund secured in the previous year.

The average outturn per acre of Egyptian cotton in Sind has been during the last four years much lower than that of the hardier indigenous variety and much less than was originally expected. This is mainly due to bad

cultivation on the part of the *ryots* who do not follow the instructions of the agricultural department. Unless cultivation is improved and sufficient flow irrigation is obtained as early as March-April, there is no likelihood of Egyptian cotton being established as a general field crop in Sind. The Government of Bombay are taking steps to secure these conditions. It is disappointing, however, to record that this year (1909) no sowings in Sind of Egyptian cotton have been made on account of the difficulties of water supply.

Some promising results have been obtained from the trials of American and Cambodia cottons in parts of the Southern Maratha country.

The area sown with American cotton in the Jhelum colony of the Punjab increased in 1907, but on account of the scarcity of labour due to the epidemic of plague, the area was restricted last year. There has been, however, no large decrease in the number of cultivators growing this cotton. Arrangements were made last winter to dispose of the produce by auction as is done with Sind-grown Egyptian cotton, and the results were most satisfactory, the cultivators obtaining an adequate price for their produce. The trials with Egyptian cotton in the Punjab have not yielded any satisfactory results. The Economic Botanist has now imported a new variety which he considers better suited to the Punjab.

Acclimatised American cotton was successfully grown in 1907 by many cultivators in the Aligarh district of the United Provinces, and there was a large increase in the demand for seed for the next year's crop. It is anticipated that the quantity of this cotton will soon be sufficient for putting it on the market on a commercial scale and the prices offered will determine whether it will be permanently established in these provinces.

In the Central Provinces and Bengal *burhi* cotton (an acclimatised variety of American type) has continued to give successful results. Efforts are being made to extend

the area under this cotton and to improve the quality and outturn by selection. In the Central Provinces arrangements were made during 1908-09 to secure a large supply of seed for distribution. It is a good cropper in districts of fairly heavy rainfall, yields a high percentage of lint of good quality and is comparatively immune to wilt.

In Madras and Burma, experiments with Egyptian and other varieties of cotton are in progress.

Tree Cottons.—Further trials with tree cottons have confirmed the opinion which I have previously expressed, viz., that they will never enter into regular cultivation in India. The experiments made by Messrs. Shaw, Wallace and Company with this class of cotton have generally failed. The chief centre of their operations was the Mourbhunj Farm. One hundred and seventy acres were planted out with perennial cottons in 1907. In the succeeding year this area was increased to about 300 acres. In August 1908 the plantations were inspected by me in company with the Director of Agriculture, Bengal, and a report was submitted to Government. The experiments had failed and therefore have been abandoned since March, 1909. Some success has been obtained with the Bourdon variety in the Bombay Presidency and favourable results have been obtained here and there in Assam and Burma, but the place of tree cottons as a field crop in Indian agriculture is very limited.

J. MOLLISON, M.R.A.C.,

Inspector General of Agriculture in India.

SIMLA;

The 5th August 1909.

REPORT OF THE DIRECTOR, AGRICULTURAL
RESEARCH INSTITUTE AND COLLEGE, PUSA,
FOR THE YEARS 1907-09.

(B. COVENTRY, ESQ.)

1. *Charge*.—The Director returned from nine months' combined privilege leave and furlough on 27th November 1907, and for the remainder of the period under report, was in charge of his office.

2. *Staff*.—The European scientific staff of the Institute consisted as follows :—(1) The Imperial Agriculturist with one Supernumerary, (2) The Imperial Agricultural Chemist with one Supernumerary, (3) The Imperial Economic Botanist with one Supernumerary, (4) The Imperial Entomologist with one Supernumerary, (5) The Second Imperial Entomologist and (6) The Imperial Mycologist with one Supernumerary. Mr. C. J. Bergtheil, Imperial Bacteriologist, who for the last five years was on deputation with the Bengal Government carrying on investigations connected with indigo manufacture, joined his appointment at Pusa on the 1st April 1909, after the expiry of his deputation, but soon after (28th June) relinquished his post. Mr. F. M. Howlett, B.A., Second Imperial Entomologist, arrived from England on the 23rd November 1907 and commenced his investigation on *diptera*. Mr. G. P. Hector, M.A., B.Sc., arrived on the 14th January 1908 and took up the post of Supernumerary Economic Botanist in succession to Mr. R. J. D. Graham, M.A., B.Sc., transferred to the Central Provinces. Mr. W. McRae, M.A., B.Sc., Supernumerary Mycologist, arrived on the 28th March 1908. Mr. W. Roberts, B.Sc., Supernumerary Agriculturist, was deputed to Bombay Presidency in April 1908 to assist the Deputy Director of Agriculture. Mr. A. G. Birt, B.Sc., Supernumerary Agriculturist, was in May 1908 transferred to the Agricultural Department, Eastern Bengal and Assam, as Acting Assistant

Director of Agriculture. Mr. E. Holmes-Smith, B.Sc., Economic Botanist-designate of Burma, arrived from England on the 7th October 1908 to undergo training under the Imperial Economic Botanist, and Mr. G. C. Sherrard, B.A., Supernumerary Agriculturist, arrived from England on the 19th November 1908. Drs. J. W. Leather and E. J. Butler proceeded on leave from the 15th and 1st April 1909 respectively, and Mr. H. E. Annett, B.Sc., Supernumerary Agricultural Chemist, and Mr. W. McRae, Supernumerary Mycologist, were appointed to officiate in the posts of Imperial Agricultural Chemist and Imperial Mycologist respectively.

3. *Scientific Work*.—The scientific work of the Institute during the period is indicated in the reports of the various sections.

4. *College, Grounds, Roads, etc.*—The College building has been taken over from the Public Works Department and has been fully occupied by the various sections. The spacious compound surrounding the College has been laid out; a general improvement in the condition of the roads and avenues has been introduced. Nearly 150 acres have been added to the cultivated area.

5. *Students*.—The College was opened for students in July 1908. The number of students admitted during the year was 19. Of these, 2 came for training in practical agriculture, 2 in economic botany (one for a special course in fruit pruning and weathering), 2 in chemistry, 7 in entomology, 3 in mycology and 3 came for a general course in agriculture. Seven students left after completion of training; one left on account of ill-health, and one was recalled to his province before completion. The student from the Central Provinces who came for a training in entomology died before completing his course. In addition to the training in the agricultural sciences above referred to, special classes have been opened to give a short industrial training in subjects such as lac cultivation and sericulture, and there are now 2 students

receiving a course of instruction in the latter subject. In the coming year it is intended to enlarge these special industrial trainings by the addition of more subjects such as fruit-growing, poultry-management, dairying, etc. It is hoped that these short courses will assist in reviving several old industries and promoting new ones which may profitably be worked as cottage industries.

6. *Publications*.—Much assistance has been given by the senior members of the staff in the preparation of publications. Special mention should be made of Dr. Leather who has had charge of the photographic department, of Mr. Maxwell-Lefroy who supervised the passing through the press of all the illustrations connected with publications, until he handed over the work to Mr. Howlett, and of the latter gentleman who, during the last year, has not only been responsible for the preparation and publication of illustrations, but has also assisted much in seeing the printed matter through the press.

7. *Library*.—The library contains over 6,000 volumes. The transfer of the books from the old building to the new, their arrangement and cataloguing have taken up a good deal of thought and time, and I am greatly indebted for the assistance that has been given in these matters by Dr. E. J. Butler, Mr. H. Maxwell-Lefroy and Mr. A. Howard. A new catalogue, revised and corrected up to 31st December 1908, is in the press.

8. *General Health of the Station*.—The general health of the station has been good. There was an outbreak of chicken-pox and acute ophthalmia amongst the menial establishment in April 1908. In March 1909, there were four cases of confluent small-pox among the subordinate staff; all recovered, and by prompt disinfection and isolation further spread of the disease was stopped. In the hospital, relief was given to 5,716 cases of whom 190 were indoor patients. The number of cases treated amongst European officials and their families was 226. The operations performed numbered 171 of which 14 were major.

REPORT OF THE IMPERIAL AGRICULTURIST FOR THE YEARS 1907-09.

(E. SHEARER, M.A., B.Sc.)

1. *Charge and Establishment.*—The Imperial Agriculturist was absent on privilege leave from 10th September to 4th October 1907, and from 2nd July to 30th September 1908, when his duties were carried on by the Director; for the rest of the period under report he was in charge of his section. Mr. A. G. Birt, Supernumerary Agriculturist, worked in the section until 8th June 1908, when he was deputed to Eastern Bengal and Assam to officiate as Assistant Director of Agriculture. Mr. G. C. Sherrard joined the section as Supernumerary Agriculturist on 20th November 1908. There have been no important changes in the subordinate staff. Excellent work has been done by Mr. Judah Hyam, Veterinary Overseer, who has been in charge of the breeding herds, Mr. Gulabbhai Desai and Mr. M. Ikramuddin, Farm Overseers, and Mr. Ziauddin Hyder, fieldman in charge of the poultry.

2. *Training.*—Four men from Eastern Bengal and Assam have completed courses of two years, nine months, six months, and three months, respectively, in practical agriculture. Of these, two are now in charge of experimental farms, one is a fieldman and the other who is a graduate in agriculture of Cornell University, United States of America, is temporarily in charge of the Dacca experimental farm, but is intended for the post of Agricultural Supervisor in his province. Two students sent by the Punjab Agricultural Department for the general course in agriculture, remained under training. Mr. Gore, Manager of the Salvation Army's farm in Gujarat, came for a short practical course last cold weather.

3. *Cropping and Character of the Seasons.*—The general cropping followed the same lines as in previous

years, being chiefly determined by the requirements of the breeding herds. Areas which promise to be suitable for future experimental work, have been treated uniformly with regard to cultivation and cropping, the produce of each acre weighed separately and the lands otherwise kept under close observation. Two blocks of 9 acres each were selected as suitable for the permanent manurial and rotation experiments referred to below.

The rainfall for the year 1907-08 was 32.35 inches (the normal being about 45 inches) and was badly distributed. There was a long break in the rains in July and August, and from the latter part of September till early January there was no rain. Cold weather sowings were made under very dry conditions, but the rains in the latter part of the cold weather were good. Notwithstanding the generally unfavourable conditions, the crops both *kharif* and *rabi* were excellent. The rainfall from the 1st of June 1908 to the 31st of March 1909 (which covers the *kharif* and *rabi* cropping seasons) was 18.23 inches. The monsoon arrived a full month later than usual and was very scanty, but *kharif* crops turned out to be little under the average. *Rabi* sowings, however, were made with very short moisture, and as practically no rain fell till the crops were in ear, the yields were reduced to less than $\frac{1}{4}$ th of the normal. The experience of the last two years would seem to fix the minimum rainfall with which good *kharif* and *rabi* crops can be successively grown on the same land, as somewhere between 20 and 30 inches, if moderately well distributed. A considerable proportion of the rainfall is lost by surface drainage in heavy falls, so that the actual crop requirements are comparatively small. But it is only on very fine grained soils, such as the north Behar alluvium, where evaporation can be reduced to a minimum by suitable cultivation, that full advantage can be taken of the actual rain absorbed by the soil, and again suitable cultivation presupposes good cattle and efficient moisture-conserving implements which in this part of India are in the hands of few.